

**DEVELOPMENT OF A ROAD MAP
FOR WHOLISTIC DEVELOPMENT
OF BAMBOO FOR SUSTAINABLE
DEVELOPMENT ,INCREASING
FARMER'S INCOME AND
ENVIRONMENT CONSERVATION**

Sustainable Options

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VISIT...

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About us...



Sustainable Options is a Bhopal based organization working for promotion of bamboo based technologies for sustainable development for over 15 years. We produce round sticks of bamboo, treat bamboo in pressure impregnation plants for its longer life , produce bamboo charcoal ,organic biochar mix , and do primary processing of bamboo for making various value added products and bamboo housing / cottages etc and generate clean power from gasification of bamboo process waste in our bamboo gasification based power plant.

Website: <http://sustainableoptions.in/>



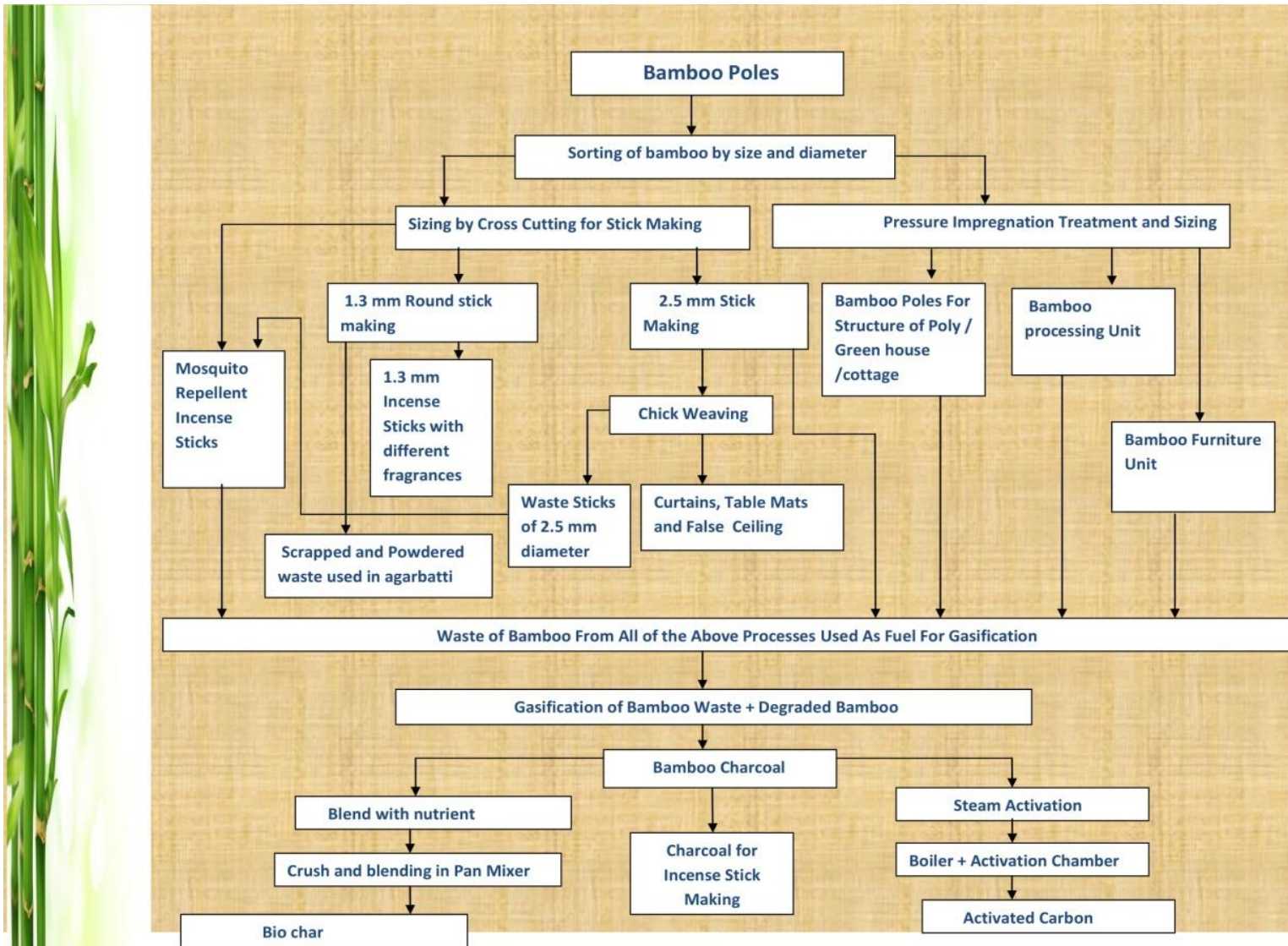


We have set up an Integrated project for bamboo processing for production of various value added products of bamboo , preservation treatment of bamboo for eco friendly structures ,bamboo chicks etc and utilisation of bamboo process waste & degraded bamboo for production of high grade bamboo charcoal & clean power generation. This is a zero waste project and provides sustainable employment opportunities for large number of local persons.

Following are our existing activities :

- Production of round sticks of bamboo for agarbatti and other products.
 - Preservation treatment of Bamboo Poles in a pressure impregnation plant
 - Production of Raw Agarbattis and Incensed Agarbattis
 - Production of Bamboo Chicks for Curtains ,False Ceilings and Yoga Mats etc
 - Primary processing of Bamboo for pre fabricated wall panels ,fibrilated strips ,slats etc
 - Construction of Pre Fabricated bamboo structures for Cottages/Gazeboes/ Polyhouses etc
 - The Bamboo Process Waste from various activities is used in a gasifier for the production of Bamboo Charcoal and clean power generation.
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Our integrated bamboo project



Significance of Bamboo

- Bamboo is a very versatile material having multiple applications and benefits for economic development and environment conservation. India is home to many species of bamboo which have different usages. In order to realize full potential of bamboo for economic development and environmental benefits, it is imperative that an integrated holistic approach is adopted for bamboo plantation, processing and value addition in consonance with specific needs of different parts of the country.
- Market survey for product need assessment and bamboo resource assessment should be carried out throughout the country. Based on the findings, specific variety of bamboo should be planted to meet the product requirement of a particular region.
- Appropriate technologies and techniques should be adopted for plantation of bamboo. Good practices of precision farming must be followed.
- Pre and post harvest management practices must be well defined and adhered to. Water management and appropriate waste management in the plantation should be adopted.
- Application of modern techniques and best practices should be ensured for promoting high quality bamboo plantation and value added products for them to be competitive -
- Large-scale plantation of appropriate species of bamboo required in a particular area/ state linked to local market needs after due assessment. This will reduce long distance transportation of bamboo will rationalize cost of bamboo and also reduce carbon footprints by reducing transportation.

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- Age of bamboo is an important criteria for its best use / application. Therefore tagging & marking on bamboo to record age is critical.
 - Plantation of appropriate species of bamboo on waste land, degraded forest land and hill slopes should be a priority to restore such land and facilitate soil conservation.
 - Need to promote buyers agreement for all bamboo plantations to protect the interest of farmers and facilitate assured sale of bamboo on maturity.
 - Bamboo plantation would facilitate climate change mitigation, get additional income to farmers through carbon credits as bamboo is now recognized as a carbon negative material. Bundling of small plantations for carbon credits can be done for additional benefits for the farmers. This will further incentivise the farmers for large scale bamboo plantation.
 - Locally grown bamboo should be locally processed to make high quality value added products and should be globally marketed.
 - Bamboo resource optimisation should be promoted through treatment and preservation of bamboo for its longer life. Horticulture and construction require large quantities of bamboo which has to be replaced frequently as untreated bamboo is prone to decay quickly.
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Integrated Bamboo Processing facility for value added products with Zero Waste

An Integrated bamboo processing facility should be set up in every district for production of various value added products of bamboo such as round sticks of bamboo ,biochar from bamboo process waste , treatment of bamboo poles in pressure impregnation plant for polyhouse and other pre-fabricated bamboo structures, raw agarbattis and clean & renewable power from bamboo gasification. Round sticks, bamboo biochar, activated charcoal, dehydrated food products and treated bamboo poles, bamboo structures for poly house, bamboo housing and garden structures have great demand in Indian market.

Suggested product range and annual production capacity in each centre for them to be economically viable and support sustainable large local employment.

1. Round sticks of bamboo for agarbatti
2. Raw agarbatti sticks
3. Bamboo Charcoal and clean renewable power from bamboo process waste -Each centre should have a gasifier system for manufacturing of bamboo charcoal and clean power generation.

Assured large market for soil amendment, cattle and fish feed , pharmaceutical,water treatment, beauty products and fuel. The global market for biochar is \$1.6 bn while India has a potential to produce huge quantity of bamboo charcoal , which is largely untapped.

4. Bamboo polyhouse made with treated bamboo poles.

Each centre should have a pressure impregnation treatment plant for treatment of bamboo using boric acid borax

5. Bamboo chick Blinds - Each centre should have complete set of powerloom, cutter and bobbin winder for chick weaving.

The bamboo chicks offer an excellent alternative to plastic roller blinds and curtains as well as synthetic material for false ceiling and other interior decoration applications. There is a large domestic and export market for bamboo chicks.

6. Power generation from the bamboo gasification plant from bamboo process waste. The power so produced is clean and renewable. It is cheaper than conventional power and can energise all the machines in the centre.

7. Fruit and vegetables dehydration facility through waste heat recovery from gasifier

8. The bamboo process waste from various activities to be used for production of Bamboo Charcoal / Biochar through bamboo gasification and clean and renewable power generation through 100% producer gas engines. The power so generated is used to operate all the machines in the integrated bamboo processing unit .

9. This integrated unit produces value added products of bamboo which would produce eco friendly materials , provide import substitution and save vital foreign exchange , facilitate sustainable employment to local persons , would facilitate higher income for farmers through bamboo plantation in the state and also facilitate climate change mitigation.



The integrated bamboo processing project can be expanded easily without heavy additional costs/efforts/time and can be scaled to any extent without disruption of ongoing operations. Engineered bamboo products such as bamboo boards and floor tiles could be added to the project once the current production stabilises.

The market for these products is steadily growing and sufficient raw material is available for years to come. The centre should tie up with local bamboo farmers who have taken up bamboo plantation.

Following is an indicative list of some value added products of bamboo which have potentially good market and would also promote self reliance by reducing dependency on imports such as round sticks, agarbattis and charcoal through an integrated approach with locally available bamboo and promotion of large scale local employment.

- Round sticks of bamboo for agarbatti and various other applications
 - Treated Bamboo structures for protected cultivation such as polyhouse, green house etc. This will not only be cost effective but would also be environment friendly and energy efficient.
 - Treated bamboo for housing ,structures for anganwadi, primary health centre, school buildings etc
 - Bamboo gasification for power generation, Production of bamboo charcoal for biochar/activated charcoal
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- Fibrilated strips of bamboo for manufacturing of bamboo boards
- Bamboo furniture specially for schools , primary health centres and anganwadis.
- Production of bamboo dust pellets for use as clean fuel.
- Bamboo fiber for making stone matrix asphalt for road construction
- Small scale and decentralized power Generation from gasification of bamboo process waste and degraded bamboo.
- Waste heat from the process can be utilised for drying of bamboo slats,vegetable dehydration etc for their longer shelf life.
- It would also facilitate a Decentralized cold storage based on waste heat from gasification
- The project is an integrated zero waste activity with multiple benefits.
- The project is a major step towards self Reliance in round sticks of bamboo,bamboo charcoal & agarbatti production and for sustainable direct employment for almost 100 local persons.
- The project will provide ready and sustained market for bamboo farmers in the state as we would require apx 30 MT of bamboo per day, i.e bamboo produced on one acre . Thus annually we would provide assured market for bamboo grown on 350 acres of land at remunerative price.

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- Engineered bamboo products such as bamboo mat boards bamboo floor tiles etc
 - Pre fabricated emergency shelters using bamboo boards / wall panels
 - Bamboo structure for toilets
 - Bamboo rings for leach pit lining of toilets
 - Bamboo handicrafts
 - Bamboo furniture
 - Bamboo textile
 - Bamboo fibre based products such as stone matrix asphalt for road construction
 - Bamboo shoots for edible usage
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For any bamboo enterprise to be viable, the entire bamboo pole has to be utilised in a gainful manner. Thus it is imperative to set up integrated bamboo processing facilities for optimum commercially viable returns.

It is well established that hundreds of products can be made from bamboo. From household items to the entire house, bamboo products are nothing new to society. In fact bamboo has potential to replace plastic in many product applications. However, training and awareness about various value addition and applications is key to promotion of bamboo applications.

Need to provide training to unemployed youth specially women in rural areas in various applications of bamboo in various sectors.

The training should cover plantation, harvesting, treatment, processing and production of value added products such as roofing sheets, flooring tiles, scaffolding materials, furniture, baskets & mat weaving and use of bamboo as biomass for power generation and large scale plantation of bamboo on wasteland. Such training programmes open up additional avenues for employment for rural poor and promote eco friendly sustainable development.



Bamboo based trades for skill development for sustainable employment

1. Bamboo Propagation through intensive cultivation of bamboo on waste land and production of organic manure from bamboo plantation
2. Appropriate Plantation techniques
3. Preservation and treatment of Bamboo for longer life
4. Primary processing of Bamboo
5. Bamboo Handicrafts and Furniture
6. Bamboo based Structure and Buildings
7. Bamboo based value added products
 - Round sticks of bamboo for agarbatti
 - Bamboo sticks brooms
 - Bamboo chick weaving
 - Bamboo charcoal soap making
 - Poly house structures using treated bamboo poles

Bamboo Charcoal / Biochar obtained from gasification of bamboo process waste

Biochar is a carbon-rich, fine-grained residue which can be produced either by ancient techniques (such as covering burning biomass with soil and allowing it to smoulder) or state-of-the-art modern biomass gasification / pyrolysis processes. Combustion and decomposition of woody biomass and agricultural residues results in the emission of a large amount of carbon dioxide, whereas Gasification / pyrolysis of such biomass would convert it to Biochar which when applied to soil can store this CO₂ in the soil leading to reduction in GHGs emission and enhancement of soil fertility.

Biochar holds the promise to tackle chronic human development issues like hunger and food insecurity, low agricultural productivity and soil depletion, deforestation and biodiversity loss, energy poverty, water pollution, air pollution and climate change.

Benefits of bamboo for making biochar

While the forest coverage in tropical and subtropical is decreasing, the bamboo forest area is increasing. It is estimated that the Bamboo area is increased annually by 1-2% per in the world and 2-3% in China. The reasons behind this phenomena are :

- ➡ Easy to be managed, high biomass production.
- ➡ High economic value.
- ➡ Bamboo timber can be harvested every year after 4-5 years, compared to 20 to 50 years for trees.
- ➡ Bamboo can be selectively harvested annually and regenerates without replanting.
- ➡ Bamboo generates 30% more oxygen than trees.
- ➡ It helps reduce carbon dioxide gases blamed for global warming. Some bamboo sequesters up to 12 tons of carbon dioxide per hectare, which makes it an efficient replenisher of fresh air.
- ➡ Bamboo biochar can increase the amount of carbon locked into the soil for hundreds or thousands of years. It also helps soil retain water, and reduce methane and nitrogen emissions.

Benefits of bamboo for making biochar

- ➔ Biochar is a carbon-rich product made from renewable agricultural/woody biomass waste residue like bamboo ,corn cobs, cotton stalk, lantana ,mulberry etc.
- ➔ We produce it through gasification of bamboo waste (heating in the absence of oxygen).
- ➔ It can be used either alone or mixed with organic additives in suitable ratio.
- ➔ Research findings and experience on the field show that there is an increase in crop yields by using Biochar Soil amendment.
- ➔ Biochar has tremendous potential for water conservation in agriculture and horticulture ,specially in poly houses/green houses and new plantations.
- ➔ It is very useful in areas where water is scarce and soil is degraded.
- ➔ It is a soil amendment that is plowed-in only once and has a lasting effect for centuries.

Biochar as an agent for soil amendment

The main scientifically approved reasons that Organic Carbon amendments have resulted in measurable improvements in soil productivity are that it:

Repairs degraded soils and resists soil erosion.

•Increases yield by 5 - 40%

Enhances soil biology (40% increase in mycorrhizal fungi)

Improves nutrient retention in soils (50% increase in Cation Exchange Capacity)

Improves the water retention capacity of soils (up to 20 % increase), thus effectively reduces water required for irrigating the soil for crop production

Increases soil organic matter

Biochar as an agent for soil amendment

The main scientifically approved reasons that Organic Carbon amendments have resulted in measurable improvements in soil productivity are that it:

Facilitates reduction of need for chemical fertilizer ,thus further reducing waterpumping forirrigation

Improves soil drainage and facilitates more neutral pH

Reduced Soil Compaction ,Increased Nutrient Cycling

Greater Retention of Water In Dry Soils

Improves Germination

•Improves Plant Resistance To Fungal Disease, Root Feeding Nematodes and Insect infestations

Effect of biochar on different soil properties

Factor	Impact	Source
Cation exchange capacity	50% increase	(Glaser et al., 2002)
Fertilizer use efficiency	10-30 % increase	(Gaunt and Cowie, 2009)
Liming agent	1 point pH increase	(Lehman and Rondon, 2006)
Soil moisture retention	Up to 18 % increase	(Tryon, 1948)
Productivity	20-120% increase	(Lehman and Rondon, 2006)
Methane emission	100% decrease	(Rondon et al, 2005)
Nitrous oxide emissions	50 % decrease	(Yanai et al., 2007)
Bulk density	Soil dependent	(Laird, 2008)
Mycorrhizal fungi	40 % increase	(Warnock et al., 2007)
Biological nitrogen fixation	50-72% increase	(Lehman and Rondon, 2006)

Biochar as an agent for climate change mitigation

Decaying or burning biomass releases CO₂ into the atmosphere and plants reabsorb it; this active carbon cycle has been in balance for millennia. Burning fossil fuels puts excessive CO₂ into the air, more than can be absorbed naturally. This traps heat in the Earth's atmosphere. Reducing atmospheric CO₂ is critical to combat climate change.

Large amounts of forestry and agricultural residues and other biomass are currently burned or left to decompose thereby releasing carbon dioxide (CO₂) and/or methane (CH₄)—two main greenhouse gases (GHGs)—into the atmosphere.

Under biochar conversion scenarios, easily mineralized carbon compounds in biomass are converted into fused carbon ring structures in biochar and placed in soils where they persist for hundreds or thousands of years.

When deployed on a global scale through the conversion of gigatons of biomass into biochar, studies have shown that biochar has the potential to mitigate global climate change by drawing down atmospheric GHG concentrations.

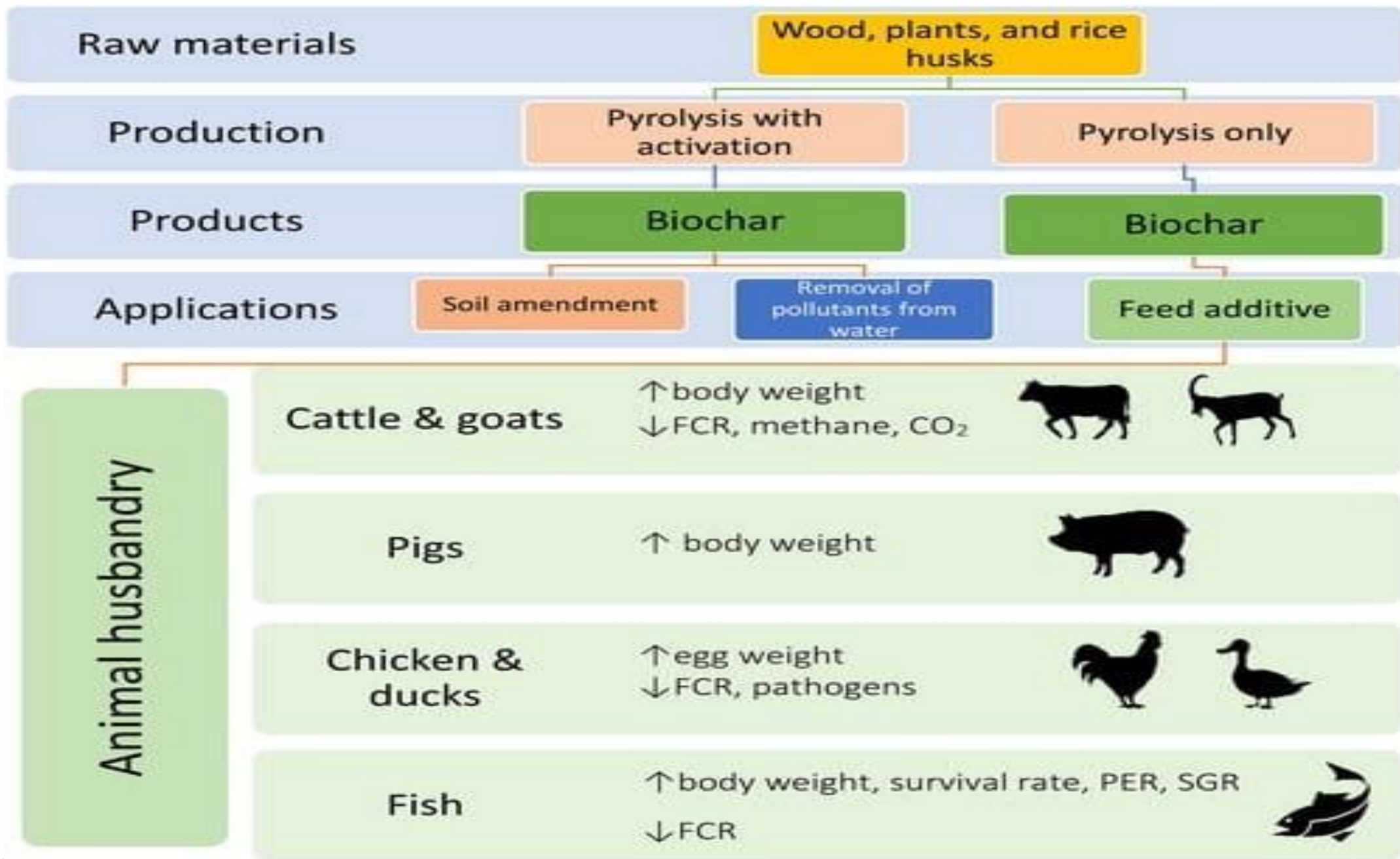
Use of Biochar in animal farming

At present approx. 90% of the biochar used in Europe goes into animal farming. Different to its application to fields, a farmer will notice its effects within a few days. Whether used in feeding, litter or in slurry treatment, a farmer will quickly notice less smell.

Used as a feed supplement, the incidence of diarrhoea rapidly decreases, feed intake is improved, allergies disappear, and the animals become calmer.

In Germany, researchers conducted a controlled experiment in a dairy that was experiencing a number of common health problems: reduced performance, movement disorder, fertility disorders, inflammation of the urinary bladder, viscous salivas, and diarrhoea. Animals were fed different combinations of charcoal, sauerkraut juice or humic acids over periods of 4 to 6 weeks.

- Biochar, has been used in acute medical treatment of animals for many centuries. Since 2010, livestock farmers increasingly use biochar as a regular feed supplement to improve animal health, increase nutrient intake efficiency and thus productivity
- Studies on beef cows in the Great Plains of the US found that adding biochar to feed reduces cows' methane emissions by between 9.5 %
- The use of biochar as feed additive has the potential to improve animal health, feed efficiency and the animal-stable environment; to reduce nutrient losses
- Oral applications of biochar from 200-400 g/day has proved beneficial.





Improved Digestion: Biochar has been shown to promote improved digestion in animals.

Increased Immunity: As an adsorbent, biochar has been shown to lock up toxins in the digestive tract. This maintains the balance of microbial activity and avoids subsequent damage to the animal's digestive system.

Reduced Chronic Botulism: Botulism in cows has been an increasing concern in recent years.

Increased Feed and Energy Efficiency: The addition of biochar to poultry feed has been shown to improve the absorption of energy from feed, ultimately improving the efficiency of the feed.

Increased Growth Rates: Increased growth rates and final body weights in broilers as a result of biochar have also been documented.

Biochar in poultry: An immediate use of biochar in poultry farming is to reduce and even eliminate odours from poultry litter, particularly ammonia.





Biochar adsorbs gases, liquids, and ions, and ammonia (NH_4^+) is all three.

Ammonia irritates skin on contact and degrades even hard tissue, such as hooves. It also attracts insects, such as flies. This is one reason biochar can even serve as a fly deterrent.

Biochar is also a catalyst to facilitate populations of microbes. Many bacteria, fungi and other simple life forms take up residence in char micropores. Feeding biochar stimulates beneficial bacteria in the GI tract to strengthen digestion and immunity. It can increase nutrient adsorption, retention, and transport to improve the liver-intestine circuit.

Biochar promotes digestion and improves feed efficiency and thus increases energy gained from feed. Toxins effectively bind to biochar, mitigating adverse effects on the digestive system and intestinal flora. The health and vitality of animals also improves, as will meat and egg production. With animals' immune systems stabilized, infection risks from pathogens decrease.



Biochar as construction material

- The two interesting properties of biochar are its extremely low thermal conductivity and its ability to absorb water up to 6 times its weight. These properties mean that biochar is just the right material for insulating buildings and regulating humidity. In combination with clay, but also with lime and cement mortar, biochar can be added to clay at a ratio of up to 50% and replace sand in lime and cement mortars. This creates indoor plasters with excellent insulation and breathing properties, able to maintain humidity levels in a room at 45–70% in both summer and winter. This in turn prevents not just dry air, which can lead to respiratory disorders and allergies, but also dampness and air condensing on the walls, which can lead to mould developing.
- The biochar-mud plaster adsorbs smells and toxins, a property not just benefiting smokers. Biochar-mud plasters can improve working conditions in libraries, schools, warehouses, factories and agricultural buildings.
- Biochar is an efficient adsorber of electromagnetic radiation, meaning that biochar-mud plaster can prevent “electrosmog”. Biochar can also be applied to the outside walls of a building by jet-spray technique mixing it with lime. Applied at thicknesses of up to 20 cm, it is a substitute for Styrofoam insulation. Houses insulated this way become carbon sinks, while at the same time having a more healthy indoor climate. Should such a house be demolished at a later date, the biochar-mud or biochar-lime plaster can be recycled as a valuable compost additive.



Use of Biochar as a decontaminant

- As a soil additive for soil remediation – for use in particular on former mine-works, military bases and landfill sites.
- Soil substrates – Highly adsorbing and effective for plantation soil substrates for use in cleaning wastewater; in particular urban wastewater contaminated by heavy metals.
- A barrier preventing pesticides getting into surface water – berms around fields and ponds can be equipped with 30-50 cm deep barriers made of bio-char for filtering out pesticides.
- Treating pond and lake water – bio-char is good for adsorbing pesticides and fertilizers, as well as for improving water aeration.

Use of Biochar in wastewater treatment

- Bio filtration of the municipal wastewater with Biochar acting as the bio adsorbent allowed to take place over a 5 day period will reduce COD concentration in the municipal wastewater by 90% upon treatment with bio-char.

Use of Biochar in textiles

- In Japan and China bamboo-based bio-chars are already being woven into textiles to gain better thermal and breathing properties and to reduce the development of odours through sweat. The same aim is pursued through the inclusion of bio-char in shoe soles and socks.
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Thank you for your attention



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